APPENDIX C

LAND NAVIGATION

1. General Instructions for the EFMB Test Board.

Each candidate must negotiate and successfully complete both the day and night courses individually. Each course will be designed to test the candidate's ability to navigate during the day using a map and lensatic compass, and at night, a lensatic compass only from a start point to an end point. Candidates will carry a flashlight or chemical light stick to be used for emergencies. All candidates will be briefed on their responsibilities to other candidates in need of first aid. Candidates will not be penalized for providing assistance, but will be allowed to retake the test without penalty if they should fail as a result of rendering aid. All performance measures must be satisfied to receive a passing score on each course.

a. Day course. The day course will be from 3,500 to 4,000 meters in length. The course will have three direction changes and must be completed within a three-hour time limit. No point on the course will be closer than 50 meters to another point. Distractor stakes may be used but they will be no closer than 50 meters to an actual lane stake or another distractor. The points will be clearly marked by signs 12 inches by 12 inches, painted half-white and half-international orange, and staked into the ground so that the bottom of the sign is not less than five feet nor more than seven feet above the ground. Each sign must have a clearly identifiable unique letter or number on it for identification.

b. Night course. The night course will be from 2,500 to 3,000 meters in length. The course will have two direction changes and must be completed within a four-hour time limit. No point on the course will be closer than 100 meters to another point. Distractor stakes may be used but they will be no closer than 100 meters to an actual lane stake or another distractor. The points will be clearly marked by signs 12 inches by 12 inches, painted half-white and half-international orange, and staked into the ground so that the bottom of the sign is not less than five feet, nor more than seven feet above the ground. Each sign must have a clearly identifiable-unique letter or number on it for identification. Artificial illumination (light sticks, etc.) may be used to mark the general boundaries of the course, but may not be used to mark the individual points.

2. **General objective.**

To measure the candidate's ability to navigate during daylight and night time hours from a start point through intermediate points and to an end point on the ground with direction changes.

	OBJECTIVES	REQUIREMENT
A. DAY COURSE	4 POINTS	3 POINTS
B. NIGHT COURSE	3 POINTS	2 POINTS

Section I

NAVIGATION EQUIPMENT AND METHODS

Compasses are the primary navigation tools to use when moving in an outdoor world where there is no other way to find directions. Soldiers should be thoroughly familiar with the compass and its uses. Part one of this manual discussed the techniques of map reading. To complement these techniques, a mastery of field movement techniques is essential. This chapter describes the lensatic compass and its uses, and some of the field-expedient methods used to find directions when compasses are not available.

C-1. **TYPES OF COMPASSES.**

a. Lensatic. The lensatic compass is the most common and simplest instrument for measuring direction. It is discussed in detail in paragraph C-2.

b. Artillery. The artillery M-2 compass is a special-purpose instrument designed for accuracy.

c. Wrist/Pocket. This is a small magnetic compass that can be attached to a wristwatch band. It contains a north-seeking arrow and a dial in degrees.

d. Protractor. This can be used to determine azimuths when a compass is not available; however, it should be noted that when using the protractor on a map, only grid azimuths are obtained.

C-2. **LENSATIC COMPASS.**

The lensatic compass (Figure C-1) consists of three major parts:

a. Cover. The compass cover protects the floating dial. It contains the sighting wire (front sight) and two luminous sighting slots or dots used for night navigation.

b. Base. The body of the compass contains the following movable parts:

(1) The floating dial is mounted on a pivot so it can rotate freely when the compass is held level. Printed on the dial in luminous figures are an arrow and the letters E and W. The arrow always points to magnetic north and the letters fall at east (E) 90° and west (W) 270° on the dial. There are two scales; the outer scale denotes mils and the inner scale (normally in red) denotes degrees.

(2) Encasing the floating dial is a glass containing a fixed black index line.

(3) The bezel ring is a ratchet device that clicks when turned. It contains 120 clicks when rotated fully; each click is equal to 3 degrees. A short luminous line that is used in conjunction with the north-seeking arrow during navigation is contained in the glass face of the bezel ring.

(4) The thumb loop is attached to the base of the compass.

c. Lens. The lens is used to read the dial and it contains the rear-sight slot used in conjunction with the front for sighting on objects. The rear sight also serves as a lock and clamps the dial when closed for its protection. The rear sight must be opened more than 45 degrees to allow the dial to float freely.

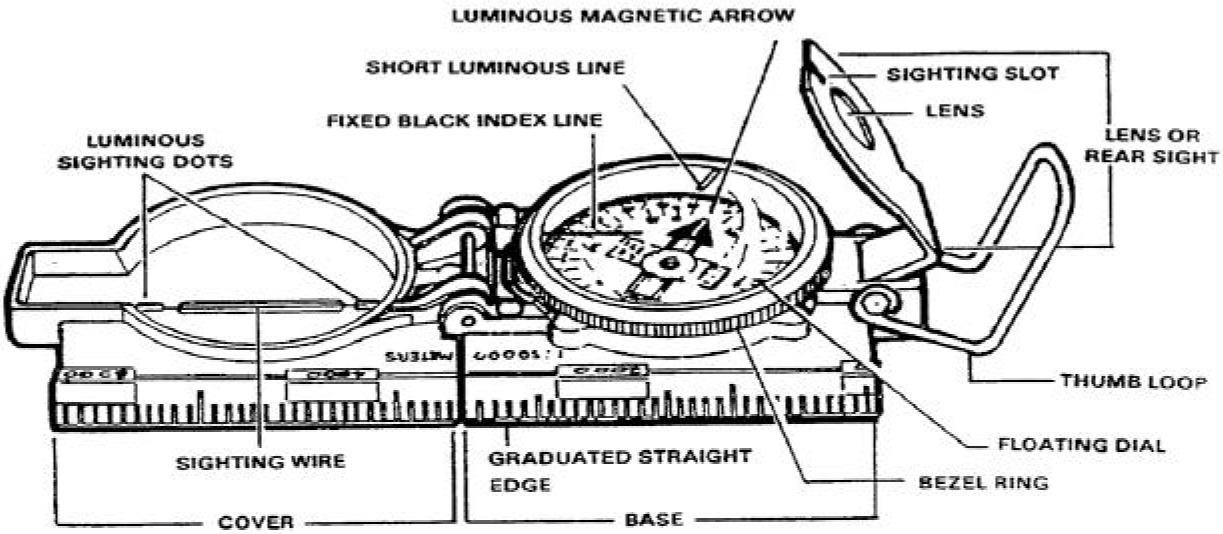

Figure C-1. Lensatic Compass

NOTE

When opened, the straightedge on the left side of the compass has a coordinate scale; in newer compasses the scale is 1:50,000.

CAUTION

Some older compasses will have a 1:25,000 scale. This scale can be used with a 1:50,000-scale map, but the values read must be halved. Check the scale.

C-3. **COMPASS HANDLING.**

a. Inspection. Compasses are delicate instruments and should be cared for accordingly. A detailed inspection is required when first obtaining and using a compass. One of the most important parts to check is the floating dial which contains the magnetic needle. The user must also make sure the sighting wire is straight, the glass and crystal parts are not broken, the numbers on the dial are readable, and most important, that the compass does not stick.

b. Effects of Metal and Electricity. Metal objects and electrical sources can affect the performance of a compass; however, nonmagnetic metals and alloys do not affect compass readings. The following are suggested as approximate safe distances to ensure its proper functioning:

(1) High-tension power lines . . . . 55 meters

(2) Field gun, truck, or tank . . . . .10 meters

(3) Telegraph or telephone wires and barbed wire . . . . .10 meters

(4) Machine gun . . . . 2 meters

(5) Steel helmet or rifle .. . . .1/2 meter

c. Accuracy. A compass in good working condition is very accurate. However, compass has to be checked periodically on a known line of direction, such as a surveyed azimuth using a declination station. Compasses with more than three degrees plus (+) or minus (-) variation should not be used.

d. Protection. If traveling with the compass unfolded, make sure the rear sight is fully folded down onto the bezel ring. This will lock the floating dial and prevent vibration, as well as protect the crystal and rear sight from damage.

C-4. **USING A COMPASS.**

Magnetic azimuths are determined with the use of magnetic instruments, such as lensatic and M-2 compasses. The M-2 compass is used primarily by the field artillery. The techniques employed when using the lensatic compass are as follows:

a. Using the Centerhold Technique (Figure C-2). First, open the compass to its fullest so that the cover forms a straightedge with the base. Move the lens (rear sight) to the rearmost position, allowing the dial to float freely. Next, place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass. Place the thumb of the other hand between the lens (rear sight) and the bezel ring; extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand. Pull your elbows firmly into your sides; this will place the compass between your chin and your belt. To measure an azimuth, simply turn your entire body toward the object, pointing the compass cover directly at the object. Once you are pointing at the object, look down and read the azimuth from beneath the fixed black index line. This method offers the following advantages over the sighting technique:

(1) It is faster to use.

(2) It is easier to use.

(3) It can be used under all conditions of visibility.

(4) It can be used when navigating over any type of terrain.

(5) It can be used without putting down the rifle; however, the rifle must be slung well back over either shoulder.

(6) It can be used without removing the steel helmet or eyeglasses.

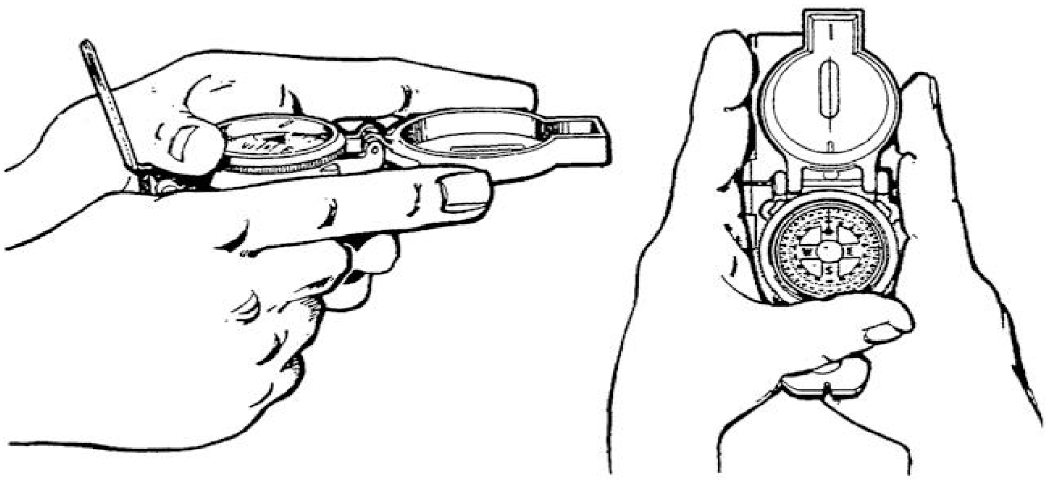

Figure C-2. Centerhold Technique

b. Using the Compass-to-Cheek Technique. Fold the cover of the compass containing the sighting wire to a vertical position; then fold the rear sight slightly forward. Look through the rear-sight slot and align the front-sight hairline with the desired object in the distance. Then glance down at the dial through the eye lens to read the azimuth (Figure C-3).

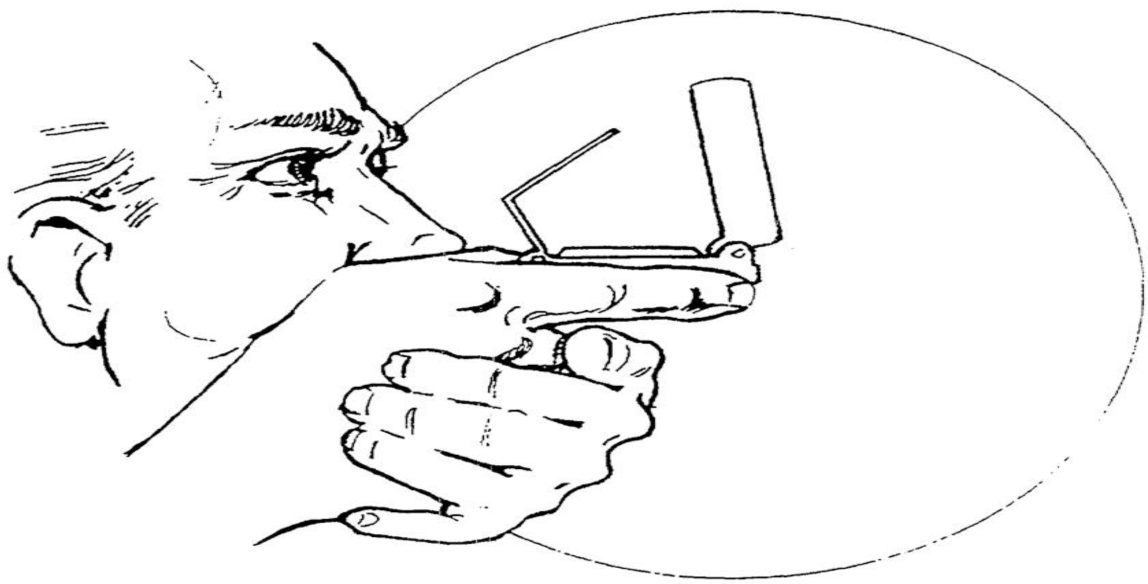

Figure C-3. Compass-to-Check Technique

c. Presetting a Compass and Following an Azimuth. Although different models of the lensatic compass vary somewhat in the details of their use, the principles are the same.

(1) During daylight hours or with a light source:

(a) Hold the compass level in the palm of the hand.

(b) Rotate it until the desired azimuth falls under the fixed black index line (example 320º), maintaining the azimuth as prescribed.

(c) Turn the bezel ring until the luminous line is aligned with the north-seeking arrow. Once the alignment is obtained, the compass is preset.

(d) To follow an azimuth, assume the centerhold technique and turn your body until the north-seeking arrow is aligned with the luminous line. Then proceed forward in the direction of the front cover's sighting wire, which is aligned with the fixed black index line that contains the desired azimuth.

(2) During limited visibility, an azimuth may be set on the compass by the click method. Remember that the bezel ring contains three-degree intervals (clicks).

(a) Rotate the bezel ring until the luminous line is over the fixed black index line.

(b) Find the desired azimuth and divide it by three. The result is the number of clicks that you have to rotate the bezel ring.

(c) Count the desired number of clicks. If the desired azimuth is smaller than 180º, the number of clicks on the bezel ring should be counted in a counterclockwise direction. For example: The desired azimuth is 51º. Desired azimuth is 51º divided by 3 equals 17 clicks counterclockwise. If the desired azimuth is larger than 180º, subtract the number of degrees from 360º and divide by 3 to obtain the number of clicks. Count them in a clockwise direction. For example: The desired azimuth is 330º. 360º – 330º = 30º divided by 3 = 10 clicks clockwise.

(d) With the compass preset as described above, assume a centerhold technique and rotate your body until the north-seeking arrow is aligned with the luminous line on the bezel. Then proceed forward in the direction of the front cover's luminous dots which are aligned with the fixed black index line containing the azimuth.

(e) When the compass is to be used in darkness, an initial azimuth should be set while light is still available, if possible. With the initial azimuth as a base, any other azimuth that is a multiple of three can be established through the use of the clicking feature of the bezel ring.

NOTE

Sometimes the desired azimuth is not exactly divisible by three, causing an option of rounding up or rounding down. If the azimuth is rounded up, this causes an increase in the value of the azimuth, and the object is to be found on the left. If the azimuth is rounded down, this causes a decrease in the value of the azimuth, and the object is to be found on the right.

d. Bypassing an obstacle.

(1) To bypass enemy positions or obstacles and still stay oriented, detour the obstacle by moving at right angles for specified distances. For example, while moving on an azimuth of 90°, change your azimuth to 180° and travel for 100 meters; change your azimuth to 90° and travel for 150 meters; change your azimuth to 360° and travel for 100 meters; then change your azimuth to 90° and you are back on your original azimuth line (Figure C-4).

(2) Bypassing an unexpected obstacle at night is a fairly simple matter. To make a 90° turn to the right, hold the compass in the centerhold techniques; turn until the center of the luminous letter E is under the luminous line (do not move the bezel ring). To make a 90° turn to the left, turn until the center of the luminous letter W is under the luminous line. This does not require changing the compass setting (bezel ring), and it ensures accurate 90° turns.

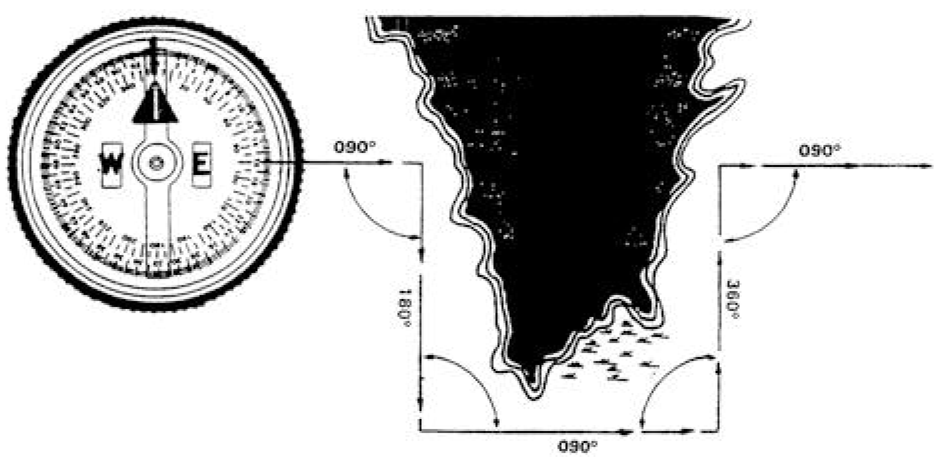

Figure C-4. Bypassing an Obstacle

e. Offset. A deliberate offset is a planned magnetic deviation to the right or left of an azimuth to an objective. Use it when the objective is located along or in the vicinity of a linear feature such as a road, stream, and so forth. Because of errors in the compass or in map reading, the linear feature may be reached without knowing whether the objective lies to the right or left. A deliberate offset by a known number of degrees if a known direction compensates for possible errors and ensures that upon reaching the linear feature, the user knows whether to go right or left to reach the objective. Ten degrees is an adequate offset for most tactical uses. Each degree offset will move the course about 18 meters to the right or left for each 1,000 meters traveled. For example, in Figure C-5, the number of degrees offset is 10. If the distance traveled to "x" is 1,000 meters, then "x" is located about 180 meters to the right of the objective.

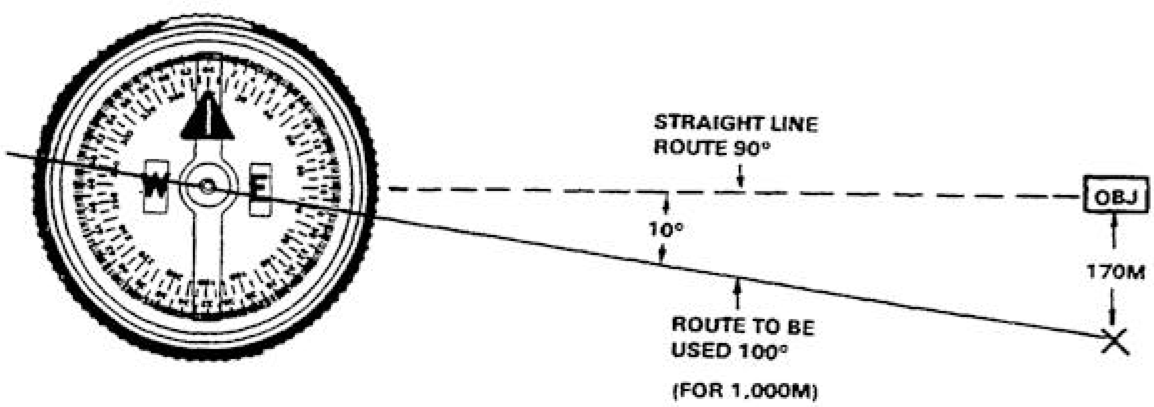

Figure C-5. Deliberate Offset to the Objective

Section II

C-5. **FIELD EXPEDIENT METHODS.**

When a compass is not available, different techniques should be used to determine the four cardinal directions.

a. Shadow-Tip Method.

(1) This simple and accurate method of finding direction by the sun consists of four basic steps (Figure C-6).

(a) Step 1. Place a stick or branch into the ground at a level spot where a distinctive shadow will be cast. Mark the shadow tip with a stone, twig, or other means. This first shadow mark is always the west direction.

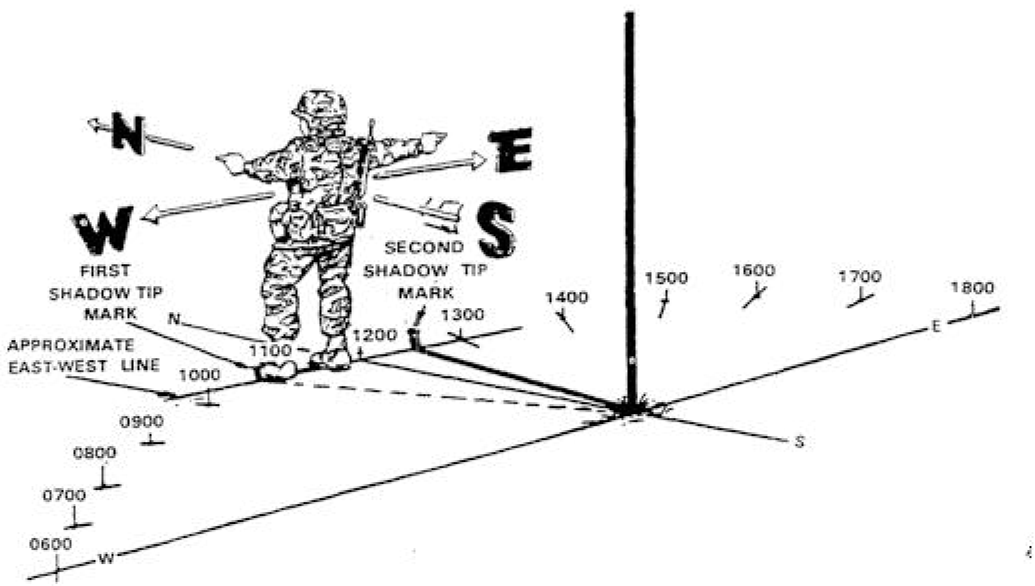

Figure C-6. Determining Directions and Time by Shadow

(b) Step 2. Wait 10 to 15 minutes until the shadow tip moves a few inches. Mark the new position of the shadow tip in the same way as the first.

(c) Step 3. Draw a straight line through the two marks to obtain an approximate east-west line.

(d) Step 4. Standing with the first mark (west) to your left, the other directions are simple; north is to the front, east is to the right, and south is behind you.

(2) A line drawn perpendicular to the east-west line at any point the approximate north-south line. If you are uncertain which direction is east and which is west, observe this simple rule--The first shadow-tip mark is always in the west direction, everywhere on earth.

(3) The shadow-tip method can also be used as a shadow clock to find the approximate time of day (Figure C-6).

(a) To find the time of day, move the stick to the intersection of the east-west line and the north-south line, and set it vertically in the ground. The west part of the east-west line indicates 0600 hours, and the east part is 1800 hours, anywhere on earth, because the basic rule always applies.

(b) The north-south line now becomes the noon line. The shadow of the stick is an hour hand in the shadow clock, and with it you can estimate the time using the noon line and the 6 o'clock line as your guides. Depending on your location and the season, the shadow may move either clockwise or counterclockwise, but this does not alter your manner of reading the shadow clock.

(c) The shadow clock is not a timepiece in the ordinary sense. It makes every day 12 unequal hours long, and always reads 0600 hours at sunrise and 1800 hours at sunset. The shadow clock time is closest to conventional clock time at midday, but the spacing of the other hours compared to conventional time varies somewhat with the locality and the date. However, it does provide a satisfactory means of telling time in the absence of properly set watches.

(d) The shadow-tip system is not intended or use in polar regions, which the Department of Defense defines as being above 60 degrees latitude in either hemisphere. Distressed persons in these areas are advised to stay in one place so that search/rescue teams may easily find them. The presence and location of all aircraft and ground parties in polar regions are reported to and checked regularly by governmental or other agencies, and any need for help becomes quickly known.

b. Watch Method.

(1) A watch can be used to determine the approximate true north and true south. In the north temperate zone only, the hour hand is pointed toward the sun. A south line can be found midway between the hour hand and 1200 hours, standard time. If on daylight saving time, the north-south line is found between the hour hand and 1300 hours. If there is any doubt as to which end of the line is north, remember that the sun is in the east before noon and in the west after noon.

(2) The watch may also be used to determine direction in the south temperate zone; however, the method is different. The 1200-hour dial is pointed toward the sun, and halfway between 1200 hours and the hour hand will be a north line. If on daylight saving time, the north line lies midway between the hour hand-and 1300 hours (Figure C-7).

(3) The watch method can be in error, especially in the lower latitudes, and may cause circling. To avoid this, make a shadow clock and set your watch to the time indicated. After traveling for an hour, take another shadow-clock reading. Reset your watch if necessary.

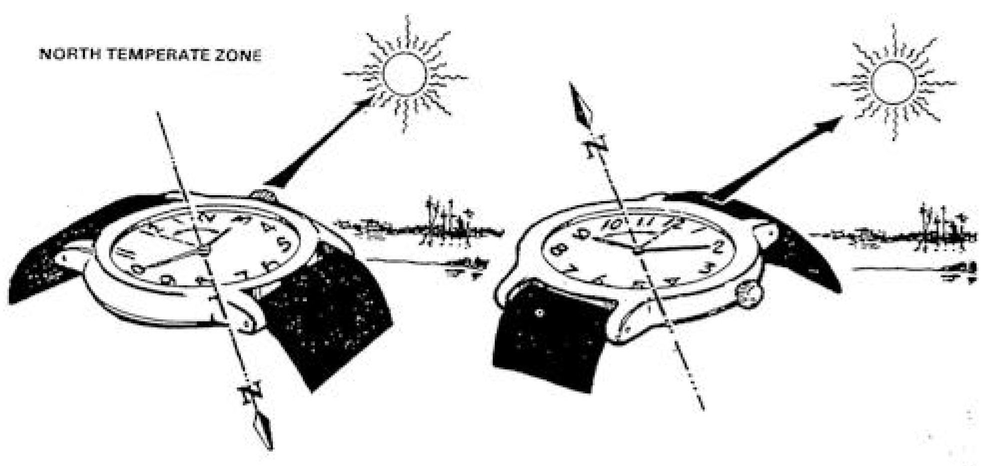

Figure C-7. Determining Directions by Using a Watch

DIRECTIONS

Being in the right place at the prescribed time is necessary to successfully accomplish military missions. Directions play an important role in a soldier's everyday life.

They can be expressed as right, left, straight ahead, and so forth; but then the question arises, "To the right of what?" This chapter contains the definition of azimuth and the three different norths, how to determine grid and magnetic azimuths with the use of the protractor and the compass, the use of some field expedient methods to find directions, the declination diagram, and the conversion of azimuths from grid to magnetic and vice versa. It also includes some advanced aspects of map reading, such as intersection, resection, modified resection, and polar plots.

C-6. **METHODS OF EXPRESSING DIRECTIONS.**

Military personnel need a way of expressing direction that is accurate, is adaptable to any part of the world, and has a common unit of measure. Directions are expressed as units of angular measure.

a. Degree. The most common unit of measure is the degree (°) with its subdivisions of minutes (') and seconds (").

1 degree = 60 minutes.

1 minute = 60 seconds.

b. Mil. Another unit of measure, the mil (abbreviated m), is mainly used in artillery, tank, and mortar gunnery. The mil expresses the size of an angle formed when a circle is divided into 6,400 angles with the vertex of the angles at the center of the circle. A relationship can be established between degrees and mils. A circle equals 6,400 mils divided by 360 degrees, or 17.78 mils. To convert degrees to mils, multiply degrees by 17.78.

c. Grad. The grad is a metric unit of measure found on some foreign maps. There are 400 grads in a circle (a 90-degree right angle equals 100 grads). The grad is divided into 100 centesimal minutes (centigrads) and the minute into 100 centesimal seconds (milligrads).

C-7. **BASE LINES.**

In order to measure something, there always must be a starting point or zero measurement. To express direction as a unit of angular measure, there must be a starting point or zero measure and a point of reference. These two points designate the base or reference line.

There are three base line—true north, magnetic north, and grid north. The most commonly used are magnetic and grid.

a. True North. A line from any point on the earth surface to the north pole. All lines of longitude are true north lines. True north is usually represented by a star.

b. Magnetic North. The direction to the north magnetic pole, as indicated by the north-seeking needle of a magnetic instrument. Magnetic north is usually symbolized by a line ending with a half arrowhead. Magnetic readings are obtained with magnetic instruments, such as lensatic and M2 compasses.

c. Grid North. The north that is established by using the vertical grid lines on the map. Grid north may be symbolized by the letters GN or the letter (y).

C-8. **AZIMUTHS.**

An azimuth is defined as a horizontal angle measured clockwise from a north base line. This north base line could be true north, magnetic north, or grid north. The azimuth is the most common military method to express direction. When using an azimuth, the point from which the azimuth originates is the center of an imaginary circle. This circle is divided into 360 degrees.

a. Back Azimuth. A back azimuth is the opposite direction of an azimuth. It is comparable to doing an "about face." To obtain a back azimuth from an azimuth, add 180 degrees if the azimuth is 180 degrees or less; or subtract 180 degrees if the azimuth is 180 degrees or more. The back azimuth of 180 degrees may be stated as 0 degrees or 360 degrees.

WARNING

When converting azimuths into back azimuths, extreme care should be exercised when adding or subtracting 180 degrees. A simple mathematical mistake could cause disastrous consequences.

b. Magnetic Azimuth. The magnetic azimuth is determined by using magnetic instruments, such as lensatic and M-2 compasses.

c. Field Expedient methods. Several field expedient methods to determine direction are discussed.

C-9. **GRID AZIMUTHS.**

When an azimuth is plotted on a map between points A (starting point) and point B (ending point); the points are joined together by a straight line. A protractor is used to measure the angle between grid north and the drawn line, and this measured azimuth is the grid azimuth.

CAUTION

When measuring azimuths on a map, remember that you are measuring from a starting point to an ending point. If a mistake is made and the reading is taken from the ending point, the grid azimuth will be opposite, thus causing the user to go in the wrong direction.

C-10. **PROTRACTOR.**

a. There are several types of protractors--full circle, half circle, square, and rectangular. All of them divide the circle into units of angular measure, and each has a scale around the outer edge and an index mark. The index mark is the center of the protractor circle from which all directions are measured. Newer military protractors (Figure 2-4, Chapter 2) contain two scales, one in degrees (inner scale) and one in mils (outer scale). This protractor represents the azimuth circle. The degree scale is graduated from 0 degrees to 360 degrees; each tick mark on the degree scale represents one degree. A line from 0 degrees to 180 degrees is called the base line of the protractor. Where the base line intersects the horizontal line, between 90 degrees and 270 degrees, is the index or center of the protractor.

b. When using the protractor, the base line is always oriented parallel to a north-south grid line. The 0-degree or 360-degree mark is toward the top of north on the map and the 90-degree mark is to the right.

(1) To determine the grid azimuth:

(a) Draw a line connecting the two points (A&B).

(b) Place the index of the protractor at the point where the drawn line crosses a vertical (north-south) grid line.

(c) Keeping the index at this point, align the 0°-180° line of the protractor on the vertical grid line.

(d) Read the value of the angle from the scale; this is the grid azimuth from point A to point B (Figure 2-4, Chapter 2).

(2) To plot an azimuth from a known point on a map (Refer to FM 21-26, Chapter 6):

(a) If necessary, convert the azimuth from magnetic to grid.

(b) Place the protractor on the map with the index mark at the center of mass of the known point and the 0°-180° base line parallel to a north-south grid line.

(c) Make a mark on the map at the desired azimuth.

(d) Remove the protractor and draw a line connecting the known point and the mark on the map. This is the grid direction line.

NOTE

When measuring an azimuth, the reading is always to the nearest half degree. Distance has no effect on azimuths.

c. To obtain an accurate reading with the protractor (to the nearest 1/2-degree), use two techniques to check that the base line of the protractor is parallel to a north-south grid line.

(1) Place the protractor where the azimuth line cuts a north-south grid line, aligning the base line of the protractor directly above the north-south grid line. The user should be able to determine whether the initial azimuth reading was correct.

(2) By placing the protractor on the map, you will see that the protractor is larger than any of the grid squares, and that it cuts at the top and bottom by at least one north-south grid line. Count the number of tick marks from the 0-degree to this north-south grid line. When the number of tick marks is equal from the 0-degree mark and 180-degree mark to this north-south grid line, the protractor is aligned properly.

C-11. **DECLINATION DIAGRAM.**

a. Definitions.

(1) Declination. Declination is the angular difference between true north and either magnetic or grid north. There are two declinations, a magnetic declination and a grid declination.

(2) Diagram. The declination diagram shows the angular relationship, represented by prongs, among these three norths. The angles between the prongs, however, are seldom plotted exactly to scale. The relative position of the directions is obtained from the diagram, but the numerical value should not be measured from it. For example, if the amount of declination from grid north to magnetic north is 1 degree, the arc shown on the diagram only represents the direction of the declination and may be exaggerated. If measured, it may have an actual value of 5 degrees. The position of the three prongs in relation to each other varies according to the declination data for each map.

b. Location. A declination diagram is a part of the marginal information under the lower margin on most larger maps. On medium-scale maps, the declination information is shown by a note in the map margin.

c. The Grid-Magnetic Angle. The G-M angle value is the angular size that exists between grid north and magnetic north and the year it was prepared. It is an arc, indicated by a dashed line, that connects the grid-north and magnetic north prongs. This value is expressed to the nearest 1/2 degree, with mil equivalents shown to the nearest 10 mils. The G-M angle is important to the map reader/land navigator because it will affect the accuracy of navigation skills in the field.

d. Grid Convergence. An arc indicated by a dashed line connects the prongs for true north and grid north. The value of the angle for the center of the sheet is given to the nearest full minute with its equivalent to the nearest mil. This data is shown in the form of a grid-convergence note.

e. Conversion. There is an angular difference between the grid north and the magnetic north that is caused by the attraction of the earth's magnetic field (Northern Canada) on all compasses. Since the location of this magnetic field does not correspond exactly with the grid-north lines on the maps, a conversion from magnetic to grid or vice versa is needed.

(1) With notes. Simply refer to the conversion notes that appear in conjunction with the diagram explaining the use of the G-M angle. One note provides instructions for converting magnetic azimuth to grid azimuth, the other, for converting grid azimuth to magnetic azimuth. The conversion (add or subtract) is governed by the direction of the magnetic-north prong relative to that of the north-grid prong.

(2) Without notes. In some cases, there are no declination conversion notes on the margin of the map; it is necessary to convert from one type of declination to another. A magnetic compass gives a magnetic azimuth; but in order to plot this line on a gridded map, the magnetic azimuth value must be changed to grid azimuth. The declination diagram is used for these conversions. A rule to remember when solving such problems is this: No matter where the azimuth line points, the angle to it is always measured clockwise from the reference direction (base line). The steps follow:

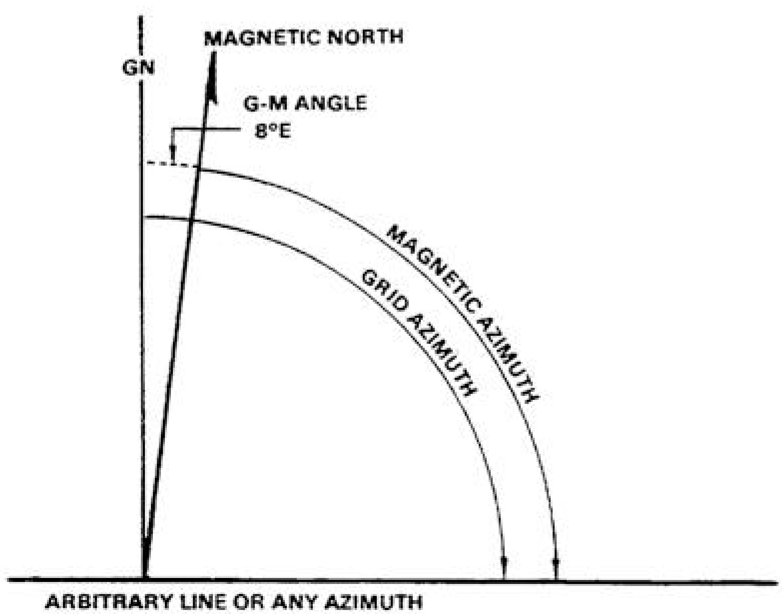

Figure C-8A. Declination Diagram With Arbitrary Line

(a) Draw a vertical or grid-north line (prong). Always align this line with the vertical lines on a map (Figure C-8A).

(b) From the base of the grid-north line (prong), draw an arbitrary line (or any azimuth line) at a roughly right angle to north, regardless of the actual value of the azimuth in degrees (Figure C-8A).

(c) Examine the declination diagram on the map and determine the direction of the magnetic north (right-left or east-west) relative to that of the grid-north prong. Draw a magnetic prong from the apex of the grid-north line in the desired direction (Figure C-8A).

(d) Determine the value of the G-M angle. Draw an arc from the grid prong to the magnetic prong and place the value of the G-M angle (Figure C-8A).

(e) Complete the diagram by drawing an arc from each reference line to the arbitrary line. A glance at the completed diagram shows whether the given azimuth or the desired azimuth is greater, and thus whether the known difference between the two must be added or subtracted.

(f) The inclusion of the true-north prong is relationship to the conversion is of little importance.

Applications.

(1) When working with a map having an east G-M angle:

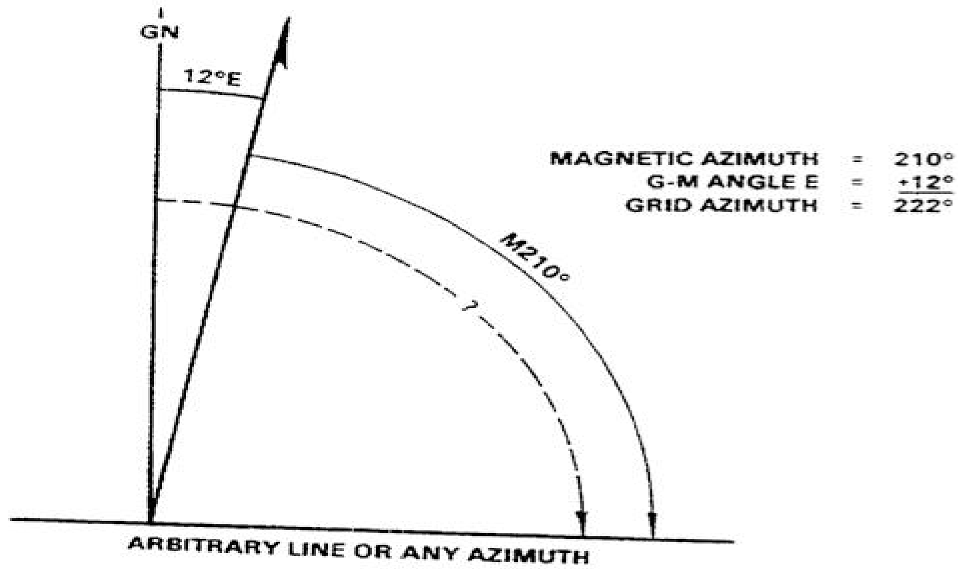

Figure C-8B. Converting to Grid Azimuth

(a) To plot a magnetic azimuth on a map, first change it to a grid azimuth (Figure C-8B).

(b) To use a magnetic azimuth in the field with a compass, first change the grid azimuth plotted on a map to a magnetic azimuth (Figure C-8C).

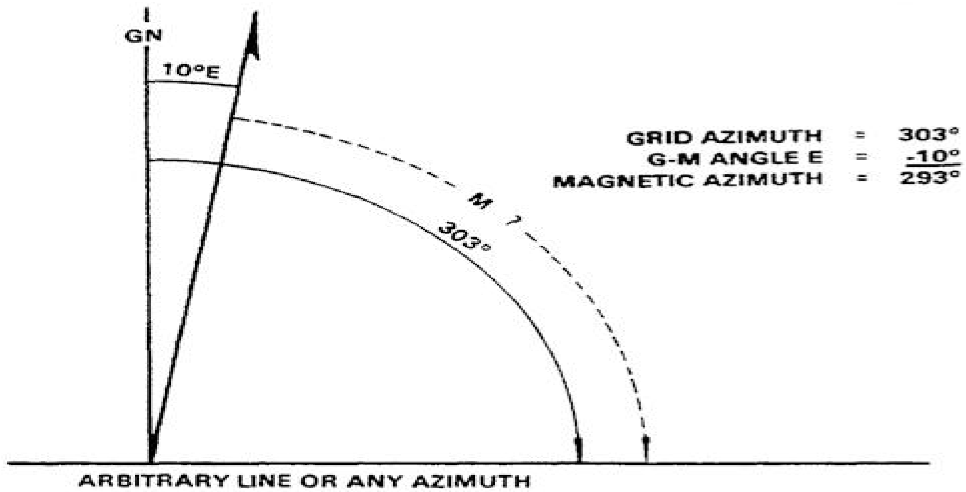

Figure C-8C. Converting to a Magnetic Azimuth

(c) Convert a grid azimuth to a magnetic azimuth when the G-M angle is greater than a grid azimuth (Figure C-8D).

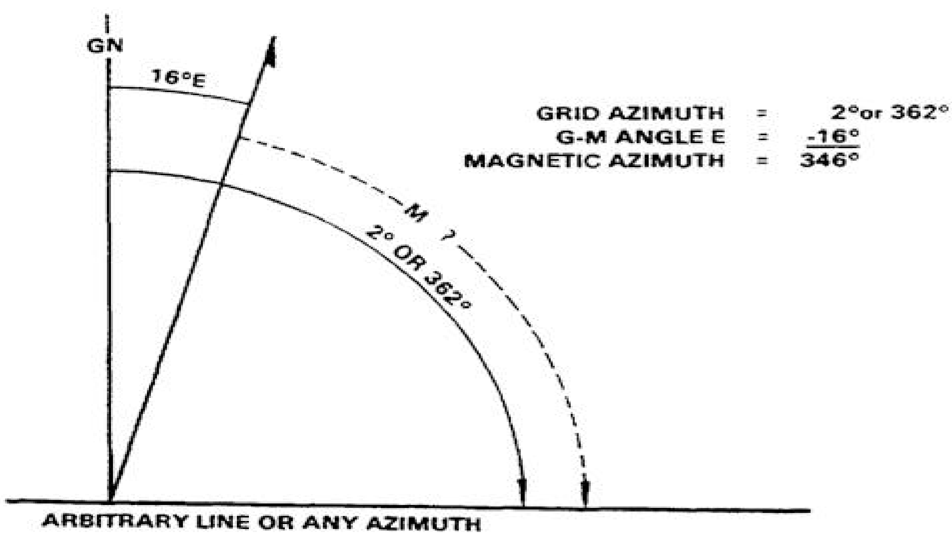

Figure C-8D. Convert to a Magnetic Azimuth When the G-M is Greater

NOTE

REMEMBER, there are no negative azimuths on the azimuth circle; since 0 degree is the same as 360 degrees, then two degrees is the same as 362 degrees. This is because 2 degrees and 362 degrees are located at the same point on the azimuth circle. The grid azimuth can now be converted into a magnetic azimuth because the grid azimuth is now larger than the G-M angle.

(2) When working with a map having a west G-M angle:

(a) To plot a magnetic azimuth on a map, first convert it to a grid azimuth (Figure C-8E).

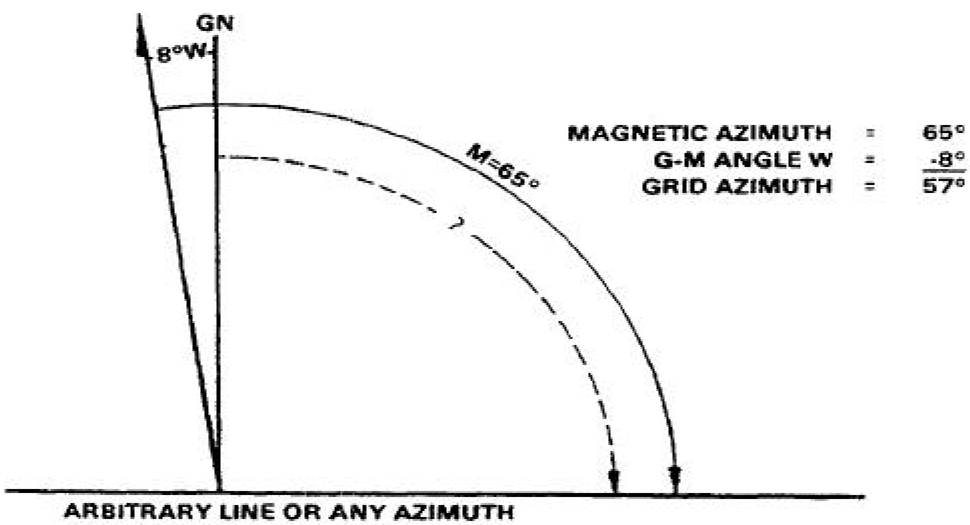

Figure C-8E. Converting to a Grid Azimuth on a Map

(b) To use a magnetic azimuth in the field with a compass, change the grid azimuth plotted on a map to a magnetic azimuth (Figure C-8F).

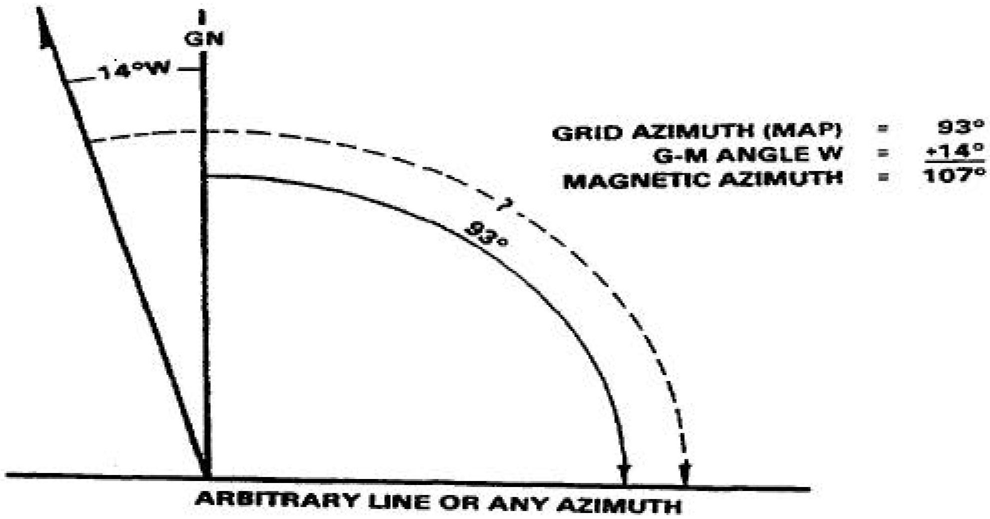

Figure C-8F. Converting to a Magnetic Azimuth on a Map

(c) Convert a magnetic azimuth when the G-M angle is greater than the magnetic azimuth (Figure C-8G).

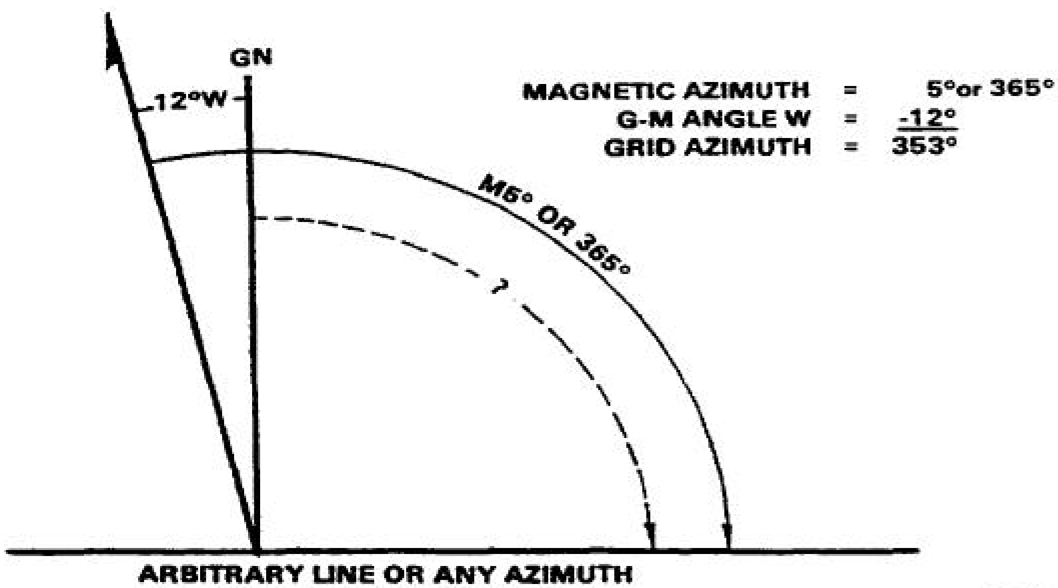

Figure C-8G. Converting to a Grid Azimuth When the G–M Angle is Greater

(3) The G-M-angle diagram should be constructed and used each time the conversion of azimuth is required. Such procedure is important when working with a map for the first time. It also may be convenient to construct a G-M-angle conversion table on the margin of the map.

NOTE

When converting azimuths, exercise extreme care when adding and subtracting the G-M-angle. A simple mistake of one degree could be significant in the field.

C-12. **INTERSECTION.**

Intersection is determining the location of an unknown point by successively occupying at least two (preferably three) known positions on the ground and then map sighting on the unknown locations. It is used to locate distant or inaccessible points or objects, such as enemy targets, danger areas, and so forth. There are two methods of intersection (refer to FM 21-26, Chapter 6).

a. Map and Compass Method.

(1) Orient the map using the compass.

(2) Locate and mark your position on the map.

(3) Determine the magnetic azimuth to the unknown position using the compass.

(4) Convert the magnetic azimuth to grid azimuth.

(5) Draw a line on the map from your position on this grid azimuth.

(6) Move to a second known point and repeat steps 1, 2, 3, 4, and 5.

(7) The location of the unknown position is where the lines cross on the map. Determine eight-digit grid coordinates to the desired accuracy.

b. Straightedge Method (when compass is not available).

(1) Orient the map on a flat surface by the terrain association method.

(2) Locate and mark your position on the map.

(3) Lay a straightedge on the map with one end at the user's position (A) as a pivot point; rotate the straightedge until the unknown point is sighted along the edge.

(4) Draw a line along the straightedge.

(5) Repeat the above steps at position (B) and check for accuracy.

(6) The intersection of the lines on the map is the location of the unknown point (C). Determine the grid coordinates to the desired accuracy.

C-13. **RESECTION.**

Resection is the method of locating one's position on a map by determining the grid azimuth to at least two well-defined locations that can be pinpointed on the map. For greater accuracy, the desired method of resection would be to use three well-defined locations.

a. Map and Compass Method (reference FM 21-26, Chapter 6).

(1) Orient the map using the compass.

(2) Identify two or three known distant locations on the ground and mark them on the map.

(3) Measure the magnetic azimuth to the known position from your location using a compass.

(4) Convert the magnetic azimuth to a grid azimuth.

(5) Convert the grid azimuth to a back azimuth. Using a protractor, scale the back azimuth on the map from the known position back toward your unknown position.

(6) Repeat 3, 4, and 5 for a second position and a third position, if desired.

(7) The intersection of the lines is your location. Determine the grid coordinates to the desired accuracy.

b. Straightedge Method (reference to FM 21-26, Chapter 6).

(1) Orient the map on a flat surface by the terrain association method.

(2) Locate at least two known distant locations or prominent features on the ground and mark them on the map.

(3) Lay a straightedge on the map using a known position as a pivot point. Rotate the straightedge until the known position on the map is aligned with the known position on the ground.

(4) Draw a line along the straightedge away from the known position on the ground toward your position.

(5) Repeat 3 and 4 using a second known position.

(6) The intersection of the lines on the map is your location. Determine the grid coordinates to the desired accuracy.

C-13. **MODIFIED RESECTION.**

Modified resection is the method of locating one's position on the map when the person is located on a linear feature on the ground, such as a road, canal, stream, etc. (refer to FM 21-26, Chapter 6). The steps are as follows:

a. Orient the map using a compass or by terrain association.

b. Find a distant point that can be identified on the ground and on the map.

c. Determine the magnetic azimuth from your location to the distant known point.

d. Convert the magnetic azimuth to a grid azimuth.

e. Convert the grid azimuth to a back azimuth. Using a protractor, scale the back azimuth on the map from the known position back toward your unknown position.

f. The location of the user is where the line crosses the linear feature. Determine the grid coordinates to the desired accuracy.

C-14. POLAR PLOT.

A method of locating or plotting an unknown position from a known point by giving a direction and a distance along that direction line is called a polar plot or polar coordinates. Three elements must be present when using polar coordinates (refer to FM 21-26, Chapter 6):

a. Present known location on the map.

b. Azimuth (grid or magnetic).

c. Distance (normally in yards or meters).